# Update to Heavy-Duty Engine Emission Conversion Factors

## (M6.HDE.002, M6.HDE.004)
### Terry P. Newell
### US EPA Office of Mobile Sources

# Heavy-Duty Emissions in MOBILE6

- Updated emission rates (g/bhp-hr) for MY 1988-2004+
- Conversion factors used to transform g/bhp-hr to g/mi rates

# Update of Emission Rates

- Certification data for MY 1988-1995 HDEs

- Weighted by sales and rated hp to obtain average for each fuel type and (for diesels) weight class

- Both zero-mile levels and deterioration rates updated

# Update of Emission Rates - Results (HDGE)

- HC:  Much lower ZMLs and DRs
- CO:  Lower ZMLs (except MY1989), lower DRs
- NOx:  Lower ZMLs, DRs slightly reduced

4

# Update of Emission Rates - Results (HDDE)

- HC:  Much lower ZMLs; DRs very low (but were zero)
- CO:  Much lower ZMLs and DRs
- NOx:  Lower ZMLs, DRs very low (but were zero)

# What are "conversion factors"?

- Units of bhp-hr/mi
- Used to convert from regulated levels (engine tests) to in-use levels (vehicle levels in use)
- Distinct for gas/diesel, for each subclass, for buses

# Update range

- Did not revise CFs for model years (MY) 1986 or earlier
- Updated CFs for MY 1987-1996
- MY 1996 values used for future model years

# Basic formula

- Same methodology used for earlier versions of MOBILE (Machiele, 1987; MVMA, 1982)
- Conversion factor (bhp-hr/mi) =

$$\frac{\textit{Fuel density (lb/ gal)}}{\textit{BSFC (lb/ hp-hr)*FE(mi/ gal)}}$$

# Difference in MOBILE6 use of HDE CFs

- MOBILE5 used single conversion factor for HDGEs and for HDDEs, weighted by CFs for various weight classes

- MOBILE6 will use CFs specific to gas and diesel HDEs by weight class (IIb thru VIIIb), and for buses (gas-school; diesel-transit, intercity, school)

# Sources of data used

- Average truck fuel economy, non-engine FE improvements:  1992 Truck Inventory and Use Survey (TIUS)
- Transit & intercity bus fuel economy: NREL study, APTA "1995 Transit Passenger Vehicle Fleet Inventory" and "1996 Transit Fact Book"

# Sources of data used

- School bus fuel economy:  National Transportation Statistics 1997, *School Bus Fleet* magazine

- Gasoline transit & intercity buses: previous work (Machiele, 1987)

- Fuel density data, for summer & winter seasons 1987-1996:  NIPER Petroleum Product Surveys

11

# Sources of data used

- BSFC data requested from 8 mfrs (6 supplied); estimates for others based on hp, specifications, engineering judgment
- Sales data from EPA used to weight BSFC within classes

12

# Methodology

- Curve fits developed for FE as function (model year)
- For buses, intercity FE estimated from transit bus FE using data from Central Business District (CBD) and Commuter (COM) cycles

# Non-Engine Fuel Economy Improvements

- Includes aerodymamic improvements, drive train optimization, radial tires, speed control, and fan drives
- Benefits of such devices mostly seen on longer, higher speed trips
- Assumed to have reached maximum penetration in fleet

# Comparison to MOBILE5 (data used)

- Higher use of non-engine FE improvements in most cases
- BSFC generally lower than used in MOBILE5
- Fuel economy generally higher than used in MOBILE5
- Fuel densities very similar to those used in MOBILE

# MOBILE6 vs MOBILE5 Conversion Factors (HDGEs)

- New CFs higher than MOBILE5 for Class IIb (8500-10,000 lb)
- New CFs lower for Classes III thru VIII

16

# MOBILE6 vs MOBILE5 Conversion Factors (HDDEs)

- Slightly higher than MOBILE5 for Classes IIb thru VII
- Lower for Class VIIIa (33,001-60,000 lb)
- Very similar for Class VIIIb (60,001+ lb)
  - slightly higher for MY1987-92, slightly lower for MY 1993+

17

# MOBILE6 vs MOBILE5 Conversion Factors (Buses)

- Higher for all diesel buses (transit, intercity, and school)
- Higher for gasoline school buses

18

# Comments on HDE Conversion Factor Reports

- ATA said that we must await 1997 TIUS
  - assumed that newer data will show more improvements, result in lower CFs

- 1997 TIUS still not available as of now

# *Summary*

- This work updates previous analyses using same methodology  with newer data

- CFs developed this way  likely best for NOx emissions

- Pollutant-specific conversion factors require data that only recently is being collected

20